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SEPTEMBER 1992

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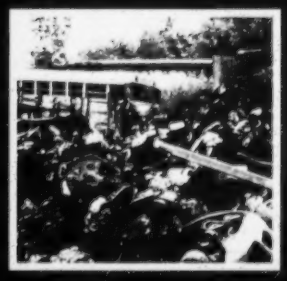
RECYCLING
WHAT'S THE PROBLEM?

Over 90% of all cars are recycled.
Only 2% of landfill waste comes from cars.
So why does the industry have to do better?



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Over 90% of all cars are recycled. Only 2% of landfill waste co

RECY(

WHAT'S THE PROBLEM?

by LINDSAY BROOKE, GERRY KOBE, JOHN MCELROY AND CHRISTOPHER A. SAWYER

The rush to recycle is on. In Europe, the US, Canada and many other countries, legislators are proposing or mandating recycling legislation to deal with a burgeoning solid waste problem.

It's easy to see why. We are simply running out of places to bury our solid waste. In the US, it is estimated that 85% of the landfills which existed in 1978 will be closed within eight years. Some are either filled or nearing capacity.

Many are closing due to tighter environmental regulations.

Twenty states now have serious landfill problems, according to the Partnership for Plastics Progress (P3), a plastics industry trade group. And this has caused the price of dumping in existing landfills to double. In many places, the dumping cost is now $100 per ton—and it keeps going up.

Currently, most laws are forcing communities to recycle their packaging and consumer products. But proposed legislation could force the automotive industry to recycle its products. In the US alone, 10 million cars and trucks are discarded every year.

"It's important that those in the automotive industry make recycling happen themselves," cautions Michael Walsh, an environmental consultant who's worked for the World Resources Institute and the EPA. "If instead the industry stumbles all over each other, pointing fingers, the heavy hand of government will come in. And government probably would not handle automotive recycling in an optimal fashion."

What kind of recycling legislation could US automakers face? You only need to look at Germany. Two years ago the German Minister of the Environment, Klaus Topfer, proposed legislation that strongly suggested all automakers in Germany had better develop a recycling system—or the government would do it for them.

To put some teeth behind its action, the Ministry of Environment proposed to reclassify un-recycled automotive materials from "light" waste to "special" waste. That alone could drive the cost of disposing automotive shredder residue—ASR, or "fluff"—to roughly $600-$1000 per ton, up from $100 per ton. Then it gave automakers until December 31, 1993 to develop a recycling system that would take the two million cars that are scrapped every year in Germany, dismantle them, recycle as many materials as possible, and properly dispose of the rest. In response, the Association of Vehicle Manufacturers, or VDA, organized a consortium called PRAVDA to develop an automotive recycling program.

So far, Herr Topfer's talk of legislation is just that—talk. To date, his Ministry has only threatened and cajoled the German automakers, who are still unsure whether they will be the ones responsible for the disposal of their products, or if independent disposal specialists will handle the task.

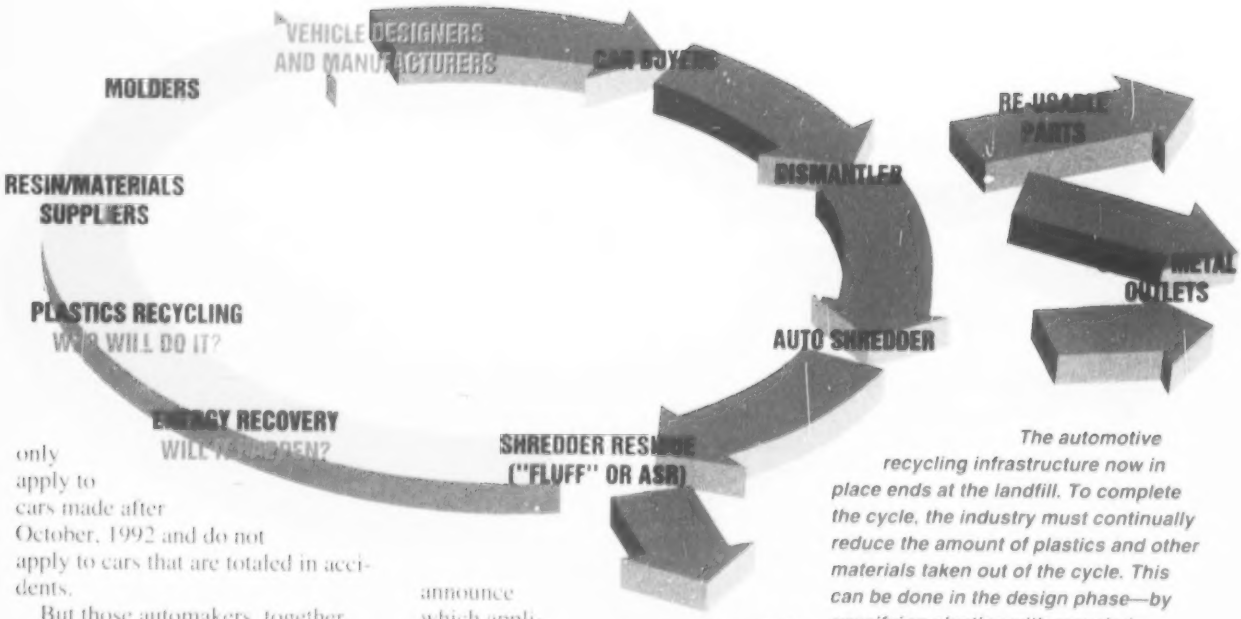
"The VDA program is the only one that has been developed and we hope the Ministry will adopt it," says Istried Hennen, a spokesman with the VDA. "But the Ministry has not released its own ideas for its program. They said they will release it this year, but they said that last year, too."

Even so, just the threat of legislation has forced automakers in Germany to "get green." Last fall, VW, Opel and Ford announced they would take back their subcompact cars at the end of their useful life and recycle them. So far, however, none have been taken back. The programs

GERMAN R&D DISMANTLING CENTERS AND RECYCLED COMPONENTS

Company	Dismantling Center	Products made from recycled plastics
Volkswagen	Leer	Golf: bumpers, wheel well liners Polo, Vento (Jetta): bumpers
Opel	Russelsheim (Now Closed)	Astra: bumper beams, wheel well liners, seat moldings, insulation mats; air filter housing
Ford	Cologne	Escort, Orion: to be announced
BMW	Landshut	All models: trunk liners
Mercedes	Tuebigen Neu-Ulm Mainz Alpine-Voest Stahl (independent co.)	S-class: wheel well liners, insulation mats, glove box and trunk liners, bumpers

...es from cars. So why does the industry have to do better?



The automotive recycling infrastructure now in place ends at the landfill. To complete the cycle, the industry must continually reduce the amount of plastics and other materials taken out of the cycle. This can be done in the design phase—by specifying plastics with recycled content.

only apply to cars made after October, 1992 and do not apply to cars that are totaled in accidents.

But those automakers, together with BMW and Mercedes-Benz, started R&D programs to develop methods and special tools to dismantle cars. To date, BMW and VW have each dismantled more than 2000 cars. And the methods learned from these R&D programs are being taught to independent disposal specialists working in conjunction with the automakers.

Additionally, German engineers are specifying recycled materials into the designs of their new cars. Opel, for example, already uses 1600 tons of post-consumer recycled plastics annually. BMW is making trunk liners out of recycled bumpers. VW's Golf and Vento (Jetta) models use bumpers containing recycled plastic. Mercedes-Benz uses recycled plastic for wheel-well liners and insulation, as well as in other applications. And Ford of Europe is soon expected to announce which applications use recycled plastics.

To ensure components will be easier to sort and recycle at the end of their useful life, German engineers are reducing the many different types of plastics they specify to just a few.

Plastics suppliers take note: Polypropylene and polyurethane are emerging as their prime choices.

Not to be outdone by the Germans, automotive recycling legislation is gathering steam in the US Congress, too. In the Senate, Max Baucus (D-MT), has provided amendments in Senate bill S.976 to the 1992 reauthorization of the Resource Conservation and Recovery Act (RCRA), which directs the EPA to conduct a study on opportunities for recycling automotive components. These amendments were passed by the Environment and Public Works committee on June 16.

Moreover, Robert Torricelli (D-NJ) introduced a bill in the House last year, the "Automobile Recycling Study Act" (H.R. 3369). His colleague Frank Lautenberg (D-NJ) has introduced the same bill in the Senate (S. 1908).

These bills, which have been referred to their appropriate committees, mandate a comprehensive study that, among other things, would set design standards to eliminate hazardous and non-recyclable materials in automobiles.

Cars and trucks attract everyone's attention because they're highly visible products, but they're also among the most recyclable of all durable goods. All together, 94% of discarded vehicles in the US are 'recycled'—a

record that would seem to satisfy even some of the "greenest" environmentalists.

But it's those "non-recyclable" materials, particularly plastics, on which the auto industry must act. Industry complacency, says Dr. Richard E. Klimisch, Executive Director, Environmental Activities Staff at GM, "could be deadly, since 75% of Americans surveyed consider themselves environmentalists."

The auto industry has had a highly profitable recycling infrastructure in place for decades. Some 12,000 auto dismantlers and reclamation yards nationwide remove and sell countless used parts from old vehicles.

When the dismantlers are done, auto shredders recover nearly 95% of the metals, selling the steel, iron, aluminum and copper to eager scrap buyers.

But this system is not very successful at recycling plastics. While the dismantlers have ready markets for a number of plastic parts, they have problems in retrieving many of them from vehicles (see sidebar, p. 51). Until recently, plastic componentry has not been marked to identify the specific resin it's made from, so dismantlers have no idea what type of material they're removing.

In 1991, a new SAE standard (J1344) established uniform coding and labelling of automotive plastics—the first step towards mass recovery of these materials and a key to more efficient dismantling—*if* the parts and assemblies are designed to be easily dismantled.

But automakers will only code parts that are new, or are on new vehicles, or are larger than a minimum size. Any carryover plastic part will probably remain uncoded until that part is changed.

There is also no deadline for automakers to code new parts. For example, not a single plastic part in Toyota's all-new 1993 T100 pickup truck is coded for recyclability, says the truck's chief engineer Shigeo Asai. That's a remarkable oversight, because Asai's team did such a good job of designing the rest of the truck's interior, particularly the instrument panel, for easy manufacture and disassembly.

The plastic bits dismantlers cannot easily remove for sale get shredded and dumped into landfills. About 25% of the original vehicle, by weight, ends up as fluff; nearly one-quarter of the fluff is plastics. The largest auto shredders in the US themselves produce over 50,000 tons of fluff each year.

Millions of tons of high-value plastics will be shredded into fluff over the next decade, until the entire fleet of new vehicles carries coded, easily dismantled plastic parts.

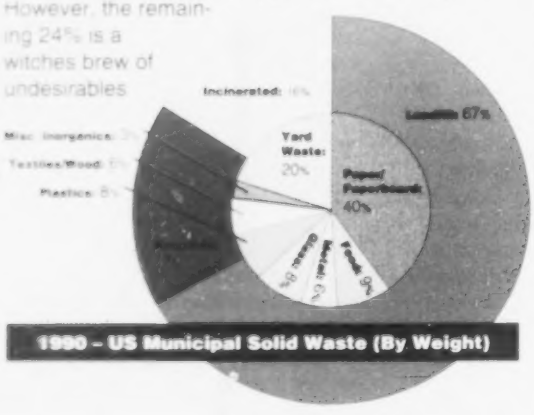
"One of our big problems right now is 'fluff,' " admits Allen Maten, Director of Automotive Programs at the P_3 Automotive Group and formerly a plastics development manager at Soivay Automotive and Ford Motor Co. "We have to figure out how we

How Much Waste is Automotive Waste?

Each US citizen creates about 4.5 lb of waste/day; the US 190 million tons/year. But automotive scrap comprises only 3.8 million tons of that total. Though 10 million automobiles are scrapped annually, the reason such a small fraction of that amount is landfilled is simple.

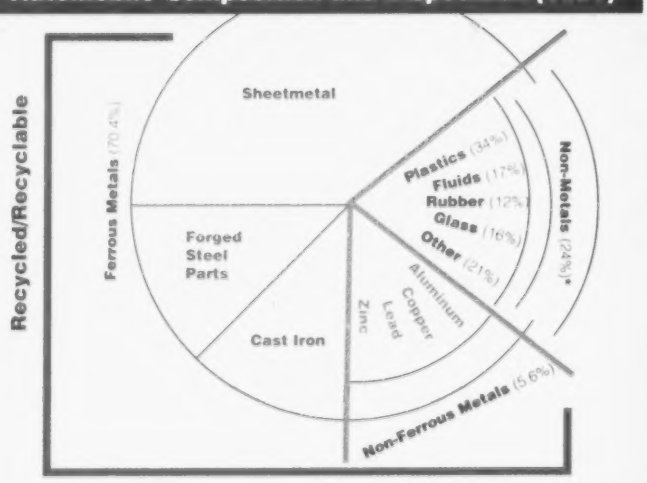
Seventy-six percent of an average automobile is recyclable. Most (70.6%) is accounted for by ferrous metals (sheetmetal, forged steel parts, cast iron), while the remainder (5.6%) is made up of non-ferrous metals (aluminum, copper, lead and zinc). However, the remaining 24% is a witches brew of undesirables that parades under the innocuous term 'fluff.' And it's this material, with its disproportionate volume/weight ratio, that is causing concern.

Fluff, which is also known as ASR, Automotive Shredder Residue, includes plastics (34%), fluids (17%),



1990 – US Municipal Solid Waste (By Weight)

Automobile Composition and Disposition (1991)

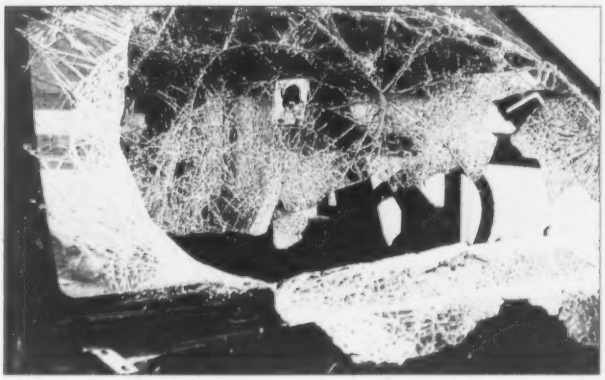


*** Automotive Landfill 3.8 Million Tons/yr**

can get these plastic parts out of the vehicles before they get shredded into fluff."

A certain amount of automotive fluff is good, say landfill operators. They spread it daily as a top-layer covering, because it absorbs, covers and packs down well. And many experts in the chemical industry believe fluff is a potential fuel for generating steam or electricity through combustion. However, while fluff has been successfully burned in laboratory and small-scale pilot projects, those same experts agree that there are major political hurdles to burning it in the real world—among them the "NIMBY" (not in my back yard) syndrome.

Meanwhile, the volume of automotive plastics is increasing: Within eight years, total plastics content of North American-built vehicles will reach nearly four billion pounds. That's roughly 275 lb of engineering plastics on every sedan. P_3's Maten says the chemical companies which



make resins know how to recycle the plastics, so the development of viable processes rests with them. And to their credit, many of the major resins producers are well into both development of promising technology and actual recycling, including:

- High-volume recycling of polypropylene (PP) battery cases. Himont USA reports that 95%-98% of all US auto batteries are recovered—totalling 150 million pounds of PP annually.

Some 40% of the recovered plastic goes into new battery cases, the rest into other automotive and consumer products.

- Recycling of reaction-injection molded (RIM) thermoplastics. Dow Plastics and Miles Inc. have developed a compression molding process where up to 10% of re-ground RIM plastic can be added to new RIM exterior auto body parts during molding.
- Recycling of nylon radiator end caps has been studied intensely by DuPont, which is encouraged that the recycling of this material can create opportunities for the recycling of other thermoplastics.
- Possible recycling solutions for

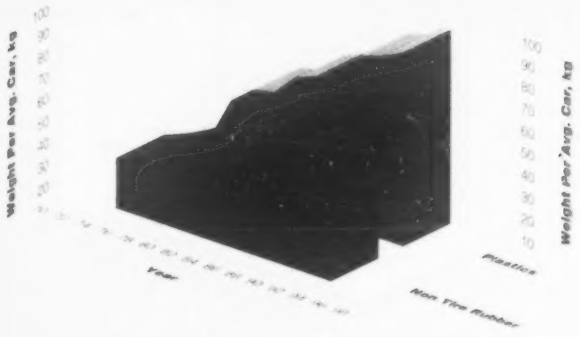
rubber (12%), glass (16%) and other materials like fibers, dirt and contaminants (21%). Almost without exception, they are sent to a landfill.

Last year, approximately 3.8 million tons of fluff were landfilled. And while a sizable slice of the automotive scrap pie, it made scarcely a dent in the overall US municipal solid waste stream. Of the 127.3 million tons of landfilled solid waste in 1990, the automobile contributed less than 3% by weight. Yet this has not stopped the automobile from becoming a target of environmentalists.

Dr. Richard L. Klimisch, Executive Director, Environmental Activities Staff at GM, says the problem facing us today is, "How do we minimize landfill, considering the number of carryover designs and the need to still determine what new designs will need to be recyclable?" Central to that process, he says, is a life-cycle analysis of the car and its parts, as well as an objective look at the various options available—and their costs.

"Recycling may cause a paradigm shift to market-based environmental regulations," says Klimisch, "but not without industry help."

Weight of Reject Material At Body Shredder



When estimates didn't agree, we used the larger of the two numbers—not to overestimate the severity of the problem, but rather to avoid underestimating it. US municipal solid waste numbers were supplied by the EPA, and these have been broken down by segment. Percentage figures for ultimate disposition of these materials were also provided by the EPA, although there were no figures as to the make up of the various sectors.

Figures delineating the material make-up of the average automobile, including the percentages recycled and landfilled are composites of figures provided by Ford, GM, Peugeot, the American Iron and Steel Institute, the Motor Vehicle Manufacturers Association and the Society of Plastics Engineers.

painted or coated thermoset plastics, such as sheet molding compound (SMC), include pyrolysis. This process, tested by General Motors and others, breaks down plastics and rubber and converts them into fuel-grade oil and gas. But pyrolysis is extremely expensive, and the results are still being analyzed to determine economic viability.

- Recycling of engineering polyester-type plastics, such as Bexloy K, was proven recently by DuPont, at its Old Hickory, TN methanolysis plant. The company successfully recycled front fenders from the Chrysler LH sedans, mixed with 2-liter soft drink bottles, and spun them into fiber that was used to make sails for the HMS Rose, a tall ship that sailed up the Hudson on July 4th.
- Mazda recently developed new reinforced thermoplastic composites which the automaker claims can be recycled up to five times and used continually for structural applications. Many high-quality engineering plastics, once recycled, can only be employed in much lower-quality uses. Mazda also developed a new decomposing catalyst to be used for reclaiming the petroleum content of plastics during recycling.
- Instrument panel (IP) substrates have been recycled using either air separation or solvent processes. An Arco Chemical program aimed at recycling the company's Dylark engineering resin has yielded 98%-99% pure resin, which Arco says can be recycled into new IP parts using a 20:80 ratio of recycled Dylark and virgin resin. Opel has recently approved the use of the recycled material in its IP components.

There are many other examples of chemical industry recycling action. What the rest of the auto industry has to do, stresses Allen Maten of the P_3 Group, is "to figure out how to get the plastics off the cars and make it economically feasible for the dismantlers and the others to recycle it. That's our goal. Steel's been doing it since the Sixties, and they've got a real head-start on us. Now it's up to us."

Maten acknowledges that for most non-metallic materials, the automotive recycling 'cycle' is incomplete. Basically, it now ends in the landfill,

instead of being a true 'cycle' that ends back at the vehicle engineer and manufacturer. That fact is echoed by Susan Day, a materials engineer and Coordinator of Vehicle Recycling at Ford Motor Co.

"We don't need a new infrastructure in American recycling," Day explains. "We just have some 'holes' in the present infrastructure that we must fix."

Plugging those holes, she notes, is automotive recycling's biggest challenge. That's part of the reason the P_3 Automotive Group was established in 1992 by the Society of the Plastics Industry. "We aren't watching from the sidelines," comments Dr. Michael Fisher, SPI~~'s director of~~ technology.

According to Allen Maten, his Group is now 'digesting' a recent pilot study done in conjunction with US auto dismantlers and shredders. The study emphasized the importance of plastics coding, parts consolidation, dismantler-friendly fastening methods and Design For Disassembly (DFD)—key parts of the 'cycle' which automotive engineers can help sustain.

"We're also looking at other major questions," says Maten. "For instance, will consumers pay some of the costs of recycling? Who's responsible for collecting and reprocessing plastics? How do we expand the currently limited market for recycled plastics?" He adds that a technical cost model has been developed for the recycling of scrapped vehicles.

A major limitation of the existing infrastructure which surfaced during P_3's study is the absence of sufficient reclamation capacity. "There just aren't many plastic reclaimers out there who have the capability to process plastics from scrapped automobiles," explains SPI's Dr. Fisher.

Today, recycling the myriad of plastics and fibers that make up vehicle interiors is a money-losing venture. And since those materials constitute a large percentage of automotive fluff, that's where most automakers' recycling efforts are currently directed.

"We realize that materials in a car right now are pretty good," says Irv Poston, Manager—Composites, GM Advanced Engineering. "It's not a matter of changing them. Certainly we don't want to take out good, value-added materials in favor of something that's more readily recyclable but won't do the job."

Sandy Labana, Manager of Polymer Science at Ford and Chairman of the Vehicle Recycling Partnership, agrees. "Ford issued a directive in late 1991, telling engineers to consider recyclability as one of the design criteria," he says. "But it cannot be at the expense of performance and quality."

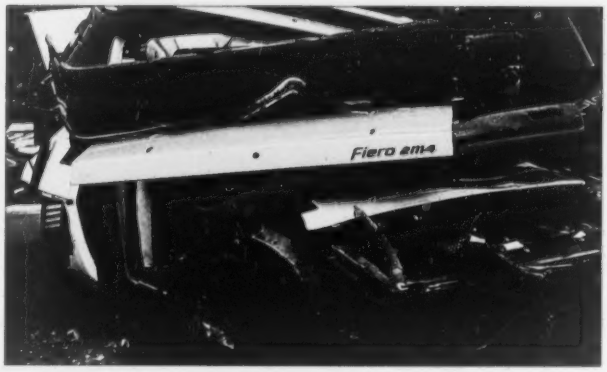
Both Poston and Labana stress that the ideal is to create a design that will be easier and more profitable for dismantlers to handle. Then, if automotive waste is made attractive enough, entrepreneurs will recognize its value, and an infrastructure will create itself. Labana cites an example of how a simple design consideration can improve the recycling of interior door panels.

"We usually make the panel stiffener out of cardboard or Masonite material, and then cover it with foam—perhaps a polyurethane. On top of that we have a fabric made of cotton or rayon, and then cover it all with something like a PVC skin. Now each of those materials is individually recyclable, but the problem is, even if you get the panel off, it requires too much labor to separate the materials. That makes it suitable only for the shredder."

As a solution, Labana proposes that all elements of the door panel—including adhesives—be made of the same polymer plastic, or at least the same family of polymers.

"It's a matter of putting the right materials together," he says. "You don't restrict materials, you restrict combinations. This adds real value to the scrap."

Of course, recovering this material in an efficient manner depends on another technology—DFD. Using



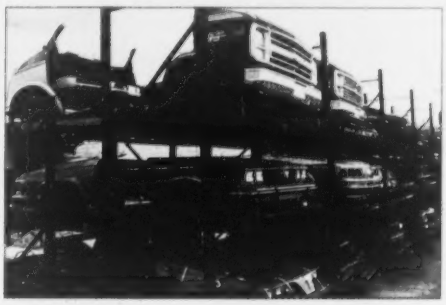
Thirty-four percent of all automotive materials that end up in a landfill are unrecycled plastics.

VOICES FROM DOWNSTREAM

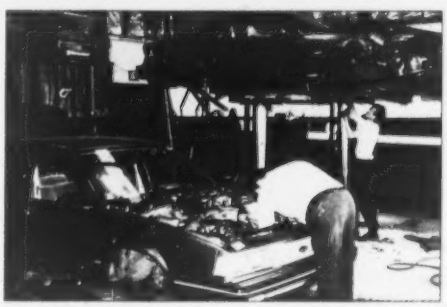
What a dismantler says about vehicle design and recyclability.

"This is not a junkyard. This is an automotive recycling and dismantling yard. May we help you?"

This sign, hung in the lobby of Schram's Auto and Truck Parts, proudly displays the credo of this family-run, Pontiac, MI-based auto dismantler. Now operated by the three grandsons of founder Harold Schram, the facility has been taking late-model GM vehicles apart for usable salvage since 1923. It's a superb example of what every dismantler should be—EPA-approved, fully computerized, and working at capacity.



"We completely dismantle two vehicles each day, with one man per vehicle," says co-owner Tom Schram, "but there's enough demand for components and sub-assemblies that we could easily add a second shift." He explains that most vehicles are purchased from insurance companies, typically for $1500-$3000. And each one costs Schram $1500 on average to store, dismantle, inventory, and dispose of the remains.



Obviously, the profit is in the parts. Some yards claim to handle 10 to 20 cars a day, but they only pull the drivetrain and doors, then ship the rest to the shredder. Dismantlers say this is because a) there are no markets for the remaining parts, especially plastics; b) those plastics are not coded, which eliminates their value; and c) it's too time-consuming to remove many items that would otherwise be saleable.

When Schram's sends its bodyshells to the shredder, they're stripped of everything that's not saleable to customers or to scrap dealers. Certain seats are pulled, if they're clean. But plastic and rubber parts are worthless, Schram says. Yards have to pay $1/tire to get rid of old tires.

"The easier it is to remove a part, or a complete assembly, the easier it is to recycle, instead of leaving it in the body to get shredded," notes Schram, adding that his company has worked with GE Plastics on recycling studies, and also did a dismantling study of the plastic-bodied APV minivan for GM. His biggest areas of concern are:

IP ASSEMBLIES: "I think design engineers try to trick us with hidden fasteners," he says. "The instrument panel should be designed for removal as an assembly. Frankly, it was easier to remove an entire dashboard in the 1970s." **PLASTICS IN GENERAL:** "Three concerns here," says Schram. "First, the number of interior parts in GM vehicles has increased. That's the wrong way to go; we should have *larger parts, and fewer of them*. Second, the [SAE J1344] codes are definitely a step in the right direction, but they bring up a bigger question: Will there be a market for all these plastics once they all get coded? Third, seat foam—unless we save the entire seat, the foam always gets sent to the shredder." **GLASS:** "We can easily sell complete windshields, backlites and windows. Unfortunately, we end up breaking 33% of them, because of the adhesives used to hold them in the vehicles. And some glass is really inefficient to remove.

GM's A-cars, for example, are the worst. There's a gasket molded to the glass—the only way to get the glass out is to remove all the interior trim, then heat the glass with a torch and melt the gasket."

DFD, automakers eliminate threaded fasteners, design breakaway parts, mold in access slots for prybars and commonize heads of fasteners that must be used.

This allows for major components to be easily removed and recycled, leaving only small, hard-to-access parts for shredding.

"My opinion is that the best solution is selective dismantling," says Labana. "Not the total dismantling approach they've taken in Germany. If we can take large components off that are optimized for recycling, and grind up the rest for further separation, recycling can be made into a viable business. That will create demand for scrap vehicles."

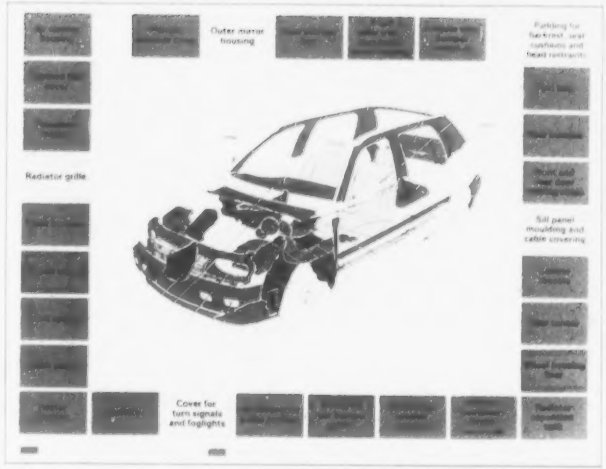
To that end, Susan Yester, Recycling Program Executive at Chrysler, says "We're not working in a vacuum trying to improve the ease of dismantling in our designs. We work directly with dismantlers to learn what is most difficult for them and how we can make it easier."

Of course, if selective recycling is adopted there will still be some residue from shredding operations. And automakers are working overtime to address the problem. In one study, GM shredded 20 plastic-bodied APV vans and put the collected material through the pyrolysis process mentioned above. Poston believes it could be a quantum leap forward in recycling.

"Right now the typical throughput in pyrolysis is one ton per hour," says Poston. "And while that's not real impressive, nobody has tried to ramp it up yet to profitable levels. With our 20 APVs we achieved a significant reduction in material volume and weight, and had only two types of residue remaining. One was a powder that could be used as a strengthening filler in roadbeds, and the other a coarser material that would probably be landfilled.

"From the SMC panels on the vans, we got back fiberglass and calcium carbonate. Both of which can be used again to make more SMC panels."

A different approach to increased recycling is specifying more recycled materials in vehicle components. Right now, the Big Three's smallest member is furthest along.



Volkswagen's dismantling center in Leer, Germany is recovering Golf bumpers, and wheel well liners, and bumpers from the Polo and Vento (Jetta). The newest Golf has been designed with much recycled plastics (shown).

"We know what's going on in Europe and we see that coming," says Chrysler's Duane Trimpe, Executive Engineer—Materials Engineering. "We want to get ahead of that and preclude the need for legislation with its restrictive time tables and restrictive way of doing things."

John Fillion, Manager—Organic Materials Engineering at Chrysler, says the company uses recycled material in its headliners, trunk dress-up, sound pads, insulation, glove box liners, sun visors, door liners and headlamp parabolas. He also adds that the company has moved away from painting plastics, choosing to mold in color instead.

"To be honest, the only time we use recycled material is when it's cheaper than virgin material," Fillion says. "But that's our whole approach. We find ways to use recycled goods and achieve a cost savings while doing it. We treat recycled material like any other raw material while evaluating it."

As a side benefit to its recycling efforts, Fillion notes that Chrysler vehicles will be using more polypropylene materials in its future vehicles, and less of a variety of plastics.

"There's no formal move to minimize the number of plastics," he says, "but it's a trend that's driven by cost. Initially, there's a loss of performance in polypropylene over an ABS material, but we've learned to modify it and design around its weaknesses. That will help from a recycling standpoint."

Another discipline that lends itself to the recycling effort is Design For Manufacture and Assembly (DFMA). By its very nature, DFMA prompts engineers to combine parts and commonize materials.

The purpose is to eliminate assembly time for smaller pieces, but in the process it creates fewer parts for dismantling.

Also, one of the objectives for DFMA is increasing the serviceability of a design. This often means less fasteners and a "no tools" approach to removing a part. Through simple design considerations, automakers can create the same profitable "pull" for recycling plastics that exists already for metals.

And if the auto industry can do that, it could raise the portion of a car than can be recycled to 90% from today's 75-80%. Politically, that should be an important goal for automakers.

Even though automobiles only account for about 2% of all the residue that gets dumped in landfills every year, many legislators perceive the auto industry as a politically popular whipping post.

But the benefits of developing a recycling infrastructure go beyond forestalling legislation. If the recycling programs now being put in place come off as planned, the auto industry will do more than reduce its contribution to the solid waste problem. It will launch an all-new industry, one that will provide low-cost materials, and potentially create thousands of new jobs. AI

by JOSEPH M. CALLAHAN

THE $25 MILLION JACKPOT

Soaring Big Three stocks have produced a big bucks bonanza for 75 auto executives and directors.

The automotive industry may still be in an overall slump, but many of its top executives and directors are swimming in gravy. Stimulated by a modest increase in vehicle sales, prices of the Big Three common stock soared an average of 63% in the first half of 1992. This produced a paper profit of more than $25 million for corporate directors and company officers who reported stock trades during those six months.

Chrysler stock led the surge with an 80% increase during the period. Ford stock rose 63%, and GM common was up 52%.

The price increases of GM's H and E common stock and the Ford B common are not included in this report. In the first half, Chrysler common jumped $9.37 a share, from $11.75 to $21.12. Ford stock increased $17.75 a share, from $28.12 to $45.87, and GM common rose $15 a share from $29 to $44.

All of this looks pretty impressive for the companies and their corporate officials. But remember that the Big Three stocks dropped significantly less than two years ago. Of course, the genius in this business appears to be Kirk Kerkorian of Tracinda Corp. who purchased 28 million shares or 9.59% of Chrysler common after the nosedive. He made an estimated $262 million during the six-month period as a result of this perceptive buy.

Other big winners in the first half were Chrysler Chairman Lee Iacocca, whose 537,273 shares of Chrysler stock earned him $5.03 million; Ford Director William C. Ford, who made $7.41 million with his 417,911 shares of Ford common; and Ford Chairman Harold Poling, who made a profit of $3.84 million with his 216,515 shares.

Former GM Chairman Roger B. Smith, still the largest individual holder of GM stock, made a profit of $875,430 in the first half with his 58,362 shares.

Interestingly, Chrysler officers and directors had an opportunity to exercise their options to buy 4,583,068 shares of Chrysler common during this period, but only sales vice-president E.T. Pappert bought Chrysler stock in the first half. Iacocca owns options to acquire 2,276,000 shares of Chrysler common. A Chrysler spokesman said the Chrysler officials failed to exercise these options because there are only so many "windows of opportunity" in which the insiders could legally purchase the stock as the result of various financial matters. AI

CHART 1
GM EXECUTIVE COMMON STOCKHOLDERS

Roger B. Smith*	58,362
Robert Stempel, Chairman	49,037
John E. Smith, President	31,399
F. Allen Smith, Exec VP	27,481
Donald Hackworth VP	25,255
James D. Johnston VP	23,906
Clifford H. Vaughan VP	23,281
Ronald Hass VP	22,991
J.T. Battenburg VP	22,765
Robert Schultz Exec VP	20,962
John O. Grettenberger VP	20,356
William E. Hoglund VP	20,012
Robert T. O'Connell GMAC	18,634
Charles T. Fisher*	14,766
James Fitzpatrick***	12,753
Edward H. Mertz VP	11,666
John G. Middlebrook VP	10,936
Aryeh E. Mainster VP	9,561
Robert J. Eaton	8,468
Richard F. O'Brien VP	8,385
Thomas S. McDaniel VP	7,723
Robert A. Frosch VP	5,537
John E. Mischi***	3,570
Gerald A. Knezetic VP	3,570
Richard M. Donnelly VP	2,880
Shirley Young VP	2,752
George C. Eads VP	2,527
John Higgins VP	2,166
Anne L. Armstrong*	1,500
J. Willard Marriott*	1,000
John J. Smale*	1,000
Dennis Weatherstone*	1,000
Thomas H. Wyman*	1,000
Malcolm R. Currie**	628
Ann D. McLaughlin*	600
Lee H. Sullivan*	500
Thomas E. Everhart*	400
Marvin L. Goldberger*	400
James A. Abrahamson*	226
Michael J. Smith	224
Edmund J. Pratt Jr.*	200
Lester Appelrad**	90

* DIRECTOR ** SUBSIDIARY OFFICER *** RETIRED

CHART 2
FORD EXECUTIVE COMMON STOCKHOLDERS

William C. Ford*	417,911
Harold A. Poling Chairman	216,515
Louis R. Ross Exec VP	92,092
Allan D. Gilmour Exec VP	85,544
Philip E. Benton President	71,030
Peter J. Pestillo VP	43,483
Edsel B. Ford II Ford Credit	38,163
Stanley A. Seneker*	27,155
Colby H. Chandler*	24,000
William C. Ford Jr.*	12,403
Drew Lewis*	7,000
Clifford R. Wharton*	6,000
Kenneth H. Olsen*	5,500
Michael D. Dingman*	5,500
Carl E. Reichardt*	4,000
Roberto C. Goizueta*	3,250
Irvin O. Hockaday*	2,000
Ellen D. Marram*	2,000

* DIRECTOR

CHART 3
CHRYSLER EXECUTIVE COMMON STOCKHOLDERS

Lee A. Iacocca Chairman	537,273
Robert A. Lutz President	47,686
Robert J. Eaton Vice-Chairman	25,000
Jerome R. York Exec VP	17,055
Peter A. Magowan*	15,160
E. T. Pappert VP	10,654
Malcolm T. Stamper*	5,516
Joseph A. Antonini*	4,210
Lillian Affinito*	3,196
Joseph A. Califano*	3,196
A. Jean de Granpre*	2,035
Robert J. Lanigan*	1,972
Kent Kresa*	1,910
Eric G. Graves*	1,804
William C. Milliken*	1,396

* DIRECTOR

Circle #126 on Reader Action Card

by LINDSAY BROOKE

ISLAND OF OPPORTUNITY

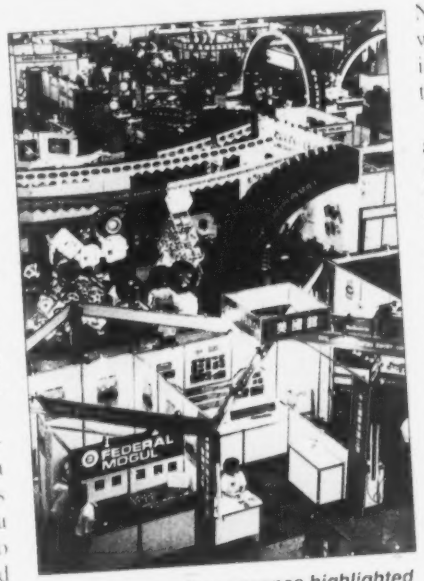
Taiwan's consumers are hungry for American vehicles. And its automotive suppliers are equally ravenous to make design and engineering deals with US firms.

Name an American-built vehicle, any vehicle, and you'll probably see it in the Republic of China: from APVs to Grand Ams to Cadillac Broughams; from Chrysler C-cars to Ford Tauruses to Toyota Camrys. Young Taiwanese hot-shoes tool through Taipei's thick city traffic in their Mustangs, Eclipses, Probes and Fieros, dodging oceans of motor scooters. Navistar, Ford and GMC trucks pick up the city's trash and put out its fires. And the cops zoom around helmetless on throbbing white Harley-Davidsons.

The Taiwanese love American vehicles, and their car market has become a ripe plum for US automakers, as *Automotive Industries* found during a recent visit to the 1992 Taipei Auto Show (actually a supplier show), and during tours of Taiwan's leading auto and component makers. In 1991, nearly $600 million worth of new US-built cars were imported—that's $220 million more than from second-place Germany. Total new car sales, including those of Taiwan's 10 domestic makers, were up 15%.

Japanese automakers are prohibited by law from importing their Japan-built cars into Taiwan. Still, Toyota was last year's top importer. It brought in 19,760 units, mostly Kentucky-built Camrys, and in doing so knocked GM into second place among the importers. The General has sold more than 100,000 cars in Taiwan since 1986, and it imported over 20,000 units in 1990. But GM's 1991 tally dropped by 47%, to 12,000 American-built cars and 2432 Opels.

"Because of the new Camry," reasoned a Taiwanese supplier executive, who spoke with *AI* at the Taipei Show, "it's this year's hot car." To address its slipping sales and consolidate its Taiwan market, GM will begin to assemble Opel Astras through a joint-venture with Chinese Automobile Co., formerly a sales channel for Yue Loong-built Nissans. By mid-1993, GM and CAC will have a new assembly plant capacitized for over 36,000 Astras per year, on two shifts.



American supplier presence highlighted the 1992 Taipei Auto Show. Can you say "joint-venture?"

Taiwan's Automotive R&D Plan

Item	1990	1995	2000
Projected Increases in R&D Expenditures	1.5%	3.25%	5%
Projected Increases In R&D Personnel	6.6%	9%	12%

Five principal automakers control about 85% of Taiwan's domestic auto market, but their volumes are small. Ford Lio Ho, generally acknowledged as Taiwan's most efficient OEM, holds a 30% market share. Lio Ho built 104,000 vehicles in 1991. Yue Loong, a Nissan affiliate, made 66,000 units, for a 20% share; Honda's San Yang (of which American Honda owns a 13% share) built 30,000 cars, accounting for a 14% market share. Rounding out Taiwan's 'Big Five' are Toyota Taiwan (10.5%) and Yue Tien (a Peugeot/Daihatsu venture, 9.4%).

These companies have a combined 400,000 unit annual capacity, which was virtually maxxed-out in 1991—they produced 388,645 vehicles, of which only 1292 were exported.

And a recent burst of joint-ventures between automakers has made *AI*'s popular "Global Joint-Venture" wall chart even more useful. Ford Lio Ho entered a technological agreement with Suzuki and GM. Yutyan is working with Peugeot/Daihatsu. Volkswagen in Germany signed a $200 million agreement with Ching Fong Investment to establish Ching Chung Motor Co. This firm will begin building small trucks in 1993, with 30,000 vehicle annual production slated by 1998. The trucks will be sold in Taiwan and exported everywhere but the US and Germany.

Currently, 50% of all Taiwan vehicle content is locally sourced, down from 70% three years ago. That rate will drop further to spur competition, trade officials told *AI*. The industry's policy is to boost local content rates only on the basis of

superior quality and pricing. Taiwan's supplier universe consists of 2000 companies of various sizes and levels of expertise. Many of these deal solely in the aftermarket. They exported $835 million in parts and components in 1991.

Supplier Opportunities

Taiwan is already becoming a small but lucrative market for some American OE suppliers, particularly those (such as Allied-Signal) involved in exhaust emissions and catalyst technology. And the potential for more opportunity is huge. The ROC Government has embarked on a massive $350 (US) billion expansion and modernization program for the country's auto industry and transportation infrastructure.

Known as the Six-Year Automobile Development Plan, it aims to upgrade the industry from its present reliance on the aftermarket—often coupled with a reputation for blatant patent infringements and spotty quality—to a global OEM player, capable of designing and producing its own complete vehicles. An electronic data interchange (EDI) system linking suppliers and automakers is also being funded.

Another program, devised by the Taiwan Transportation Vehicle Manufacturer's Association and also funded by the government, will raise industry R&D expenditures and staff levels through the year 2000 (see chart). Included will be the construction of various tech centers and test facilities.

The Taiwanese desperately want to improve their technical capability, particularly that of OE suppliers. In interviews with *AI*, Taiwanese supplier executives stressed their need for US OEM assistance now and beyond the Six-Year Plan's 1996 finale.

"We are building our own OE components and systems industry," said John S.L. Chung, President of the Automobile Parts Manufacturing Committee of the Vehicle Manufacturers' Association, "so we must develop in-house engineering and design capabilities. We hope to establish joint-ventures with American or European companies, to develop new techniques in parts design and production engineering."

Chung noted specific interest in anti-lock brakes, fuel injection and emissions control—systems that are targeted for Taiwanese development and production (see chart above). He said that two 'technology delegations' visited Detroit recently.

Taiwan's first home-grown car, Yue Loong's 'Feeling 102' (yes, there's an obvious need for nameplate refinement, too), was exported in late 1991—a milestone for the industry. But it had a Nissan engine. A major goal of Taiwan's auto industry is to develop its indigenous passenger car engines.

The 'common engine program,' as it was initiated by the Ministry of Economic Affairs, will produce a family of four-cylinder, overhead cam engines, the first debuting in 1995. These will be two 1.6 L engines (with both four-valve and two-valve cylinder heads), and a two-valve 1.2 L. Officials estimate that these engines will help reduce automakers' costs, by eliminating bought-in engines, by at least 30%. Nine Taiwanese automakers, suppliers and machine tool companies are participating in the $200 million project. Britain's Ricardo Consultants and Lotus Engineering are handling the engines' basic design, with ignition system development by Lucas.

There are three main reasons US OEM suppliers should sell in Taiwan and establish links with Taiwanese suppliers, according to Craig Allen, Manager of the American Institute in Taiwan Trade Center:

1. Although 20 of them have received

Taiwan's Components and Systems Strategy

Component/ System	Planned Year of Completion	Estimated Quantities (units)	Est. Annual Production Value After Completion
ABS	1994	250,000	NT$10b
Steering System	1994	250,000	NT$5b
Exhaust Emission/ Catalytic Converter	1995	500,000	NT$10b
'Common Engines' [1]	1995	200,000 (domestic) 120,000 (export)	NT$20b
Electronic Control Systems	2000	500,000 (domestic) 1,000,000 (export)	NT$40b

[1] Developed by Ricardo and Lotus Engineering. NT=New Taiwan Dollar (NT$1=US$.05)

Eyeing the Mainland

No auto industry in the world is watching mainland China as closely as Taiwan's. When *AI* visited Tamp Auto Parts, a major OE supplier of steering and drivetrain components (and Ford Q1 Award winner), we were given the low-down on China by Dr. Cheng Chen, Tamp Auto's General Manager.

China's current regime "is recognizing that a freer market comes with more plurality," Chen said confidently. He noted that the nine mainland provinces along the China Sea "are already a free market—they'll never go back. And those coastal provinces represent 1.2 billion people. Even if you could get just 1% of the total mainland market, that means 10.2 million people!"

Mainland China now has six automakers—three 'big' ones (Shanghai Volkswagen, Citroën and Falvet), and three smaller ones (Beijing Jeep, Quancho Peugeot and Tienchieu/Daihatsu). "The Communists have said that six carmakers are enough," Chen said. "But vans and small trucks are an exception. That's how Taiwan's auto companies are going to enter the mainland, through small trucks."

—LB

quality awards from the US Big Three, Taiwan's domestic suppliers generally are not world-class.

"US suppliers have a real advantage over the locals in cost, due to their economies of scale," Allen noted. "The guy in the States is making 10 times more than his Taiwanese counterpart."

Allen explained that US suppliers have kept out of Taiwan in the past because the country "is 'off their screens.' They figure these guys are just captives of the Japanese. They don't bother to try here. But Taiwan could become a decent 'niche' market for American suppliers, like it's become for Allied-Signal and TRW."

A logical point for US suppliers to start is with Ford, whose Lio Ho affiliate is widely respected as Taiwan's top automaker in cost, productivity and quality. Allen also suggested that US suppliers which do business with Honda's American plants should consider that company's Taiwanese affiliate San Yang, maker of Civics, Accords and motorcycles.

2. Taiwan's tariff rates have dropped dramatically—from 25% to 15%—and are due to drop again. This makes US products much more competitive. Also, the US dollar is weak in Taiwan; many price-sensitive items can now do well there.

We visited three top Taiwanese supplier plants and were generally impressed with use of SPC, small lot production, cell manufacturing, overall balance of automation and manpower, and cleanliness.

3. Japanese auto companies are virtually frozen out of the market. And American automakers and suppliers have far better name recognition in Taiwan than do the Japanese, say Taiwanese auto executives. The AIT's Allen agrees.

"US suppliers carry prestige names here," he said. "AC Rochester, for example, has a superb image in the aftermarket that will benefit them as an OE supplier." Another factor mentioned in the industry is that the Chinese still harbor painful memories of Japan's conquest and brutal occupation of their country in the 1930s through World War II. When given a choice, they're generally much more receptive to doing business with American companies.

The window of opportunity that now exists in Taiwan for the US automotive industry might soon close. If Taiwan is admitted into the General Agreement on Trade and Tariffs (GATT), there could be international pressure on them to open their market to the Japanese.

"The worst thing the Taiwanese fear is the US replaced by the Japanese here," commented Allen. "That would increase their trade surplus with the US and increase their trade deficit with Japan. The Japanese could then grab between 66% and 75% of the Taiwanese market."

[As of late spring, the Taiwan-US trade surplus was up 49% over 1991 levels, mainly due to consumer electronics, garments, toys and machinery. Taiwan has a $4.03 billion trade surplus with all of its trading partners.] *AI*

A New Breed of Designer

U/E/N Art and Technology is Taiwan's first independent automotive design/engineering company. Its staff represents the 'new breed' of Taiwanese automotive professional—Western-educated, globally focused and eager to make the necessary commitments for success.

U/E/N's point man is automotive design manager Ishun Lin. He's a 1988 graduate of the prestigious Center for Creative Studies (CCS) in Detroit, who worked at GM's Advanced Concepts Center (on the Impact electric car's interior), Renault's design studios in France and at Toyota's Calty studio in California. Lin's four design colleagues at U/E/N are all graduates of CCS and the Art Center School of Design.

Their first complete vehicle was the hit of the '92 Taipei Show—Taiwan's first superbike. Although it utilizes a Japanese four-cylinder engine, U/E/N produced everything—from basic sketches and CAD/CAE work, to clay, fabrication, paint and assembly of the radically styled show bike. And they did it in just four months.

"We combine flexibility, speed and exacting quality in our work," said Lin, as he showed me the details of the animal-looking machine. The headlamps extend telescopically, and there's a built-in digital security system. Body panels are flawless, the overall design provocative and original.

This was U/E/N's first step toward bigger projects, Lin explained. "We now have a project with a Taiwanese automaker for a small commercial van. We're doing the entire process, from sketch to clay to prototype. There's a big market in mainland China for small pickup trucks, vans and motorcycles. We can contribute much to new vehicle designs for any market."

Contact Ishun Lin at U/E/N Art and Technology, Inc. Phone 03-322-2222; fax 03-322-3133. —*LB*

Automated Highways

Japan takes a different approach.

by JIM HAUGEN

According to the Japanese, the most important part of Intelligent Vehicle Highway Systems (or, in their terms, Info-Mobility) is Advanced Vehicle Control Systems—AVCS. They feel that while advanced travel information systems and advanced traffic control systems will improve transportation efficiency, they can only indirectly improve basic problems, like accidents and congestion. The Japanese believe AVCS technology, or automated highways, are needed to provide permanent solutions.

The US IVHS effort, while including AVCS, appears to lack the Japanese conviction. Perhaps the difference is rooted in the accepted view of country cultural differences; the US absorbed with the short-term and the Japanese willing to look more long-term. Or, perhaps, the difference simply reflects differences in need. Japanese space constraints and traffic density make their highway system a much more important, and valuable, asset.

The scope of AVCS is somewhat similar in both countries, ranging from electronic co-pilot systems for collision avoidance to automated highway systems. But major differences exist in the respective approaches.

The US AVCS effort is driven by a Congressional mandate to demonstrate an Automated Highway System (AHS) by 1997. Fortunately, the Federal Highway Administration recognizes that such a demonstration should be only one of many milestones on the long road of development and deployment of a national AHS system.

The immediate FHWA goal is to come out with a Broad Agency Announcement (BAA) on AHS in October. This BAA will lead to the award of five to 10 competitive study contracts. The initial focus is to get on with early concept studies and then select the best of AHS ideas for further development.

The Japanese AVCS effort is termed Super Smart Vehicle Systems. SSVS is outlined as a 20- to 30-year program covering three decade-long phases of implementation. As shown in the attached figure, an astounding reduction in vehicle accidents of up to 43% is expected to result by the end of the third decade. This reduction will be achieved by market penetrations of 10% to 80% of the various AVCS technologies listed. SSVS is being coordinated by MITI and involves 20 or so major organizations—including Nissan and Toyota.

SSVS consists of four parts, with some highly innovative driving concepts embodied within each part.

Part one is termed the Cooperative Driving System. This system will use radar and vehicle-to-vehicle communications to coordinate the movement of vehicles with respect to each other. Each driver, or automated vehicle, as the case may be, will be given information on the maneuver intentions of all adjacent vehicles, especially for lane changing and merging.

Part two is the most unusual. It is entitled Control Configured Vehicle System with Ultra-Little Vehicles. It is an [CONTINUED ON PAGE 98]

Market Penetration of the SSVS Technologies

Phases SSVS Technologies	I by 2000	II by 2010	III by 2020
Obstacle Detection	20%	50%	80%
Road Geometery Detect.	10%	40%	40%
Collision Warning	10%	60%	80%
Auto. Braking/Steering		10%	60%
Pedestrian Detection At Intersections		10%	60%
Driver Assistance At Intersections		10%	60%
Auto. Lane Following			10%

Accident Decrease by the SSVS Technologies

Phases SSVS Technologies	I by 2000	II by 2010	III by 2020
No. of Decreases	415	1896	4090
Ratio of Decreases	4.4%	20.1%	43.4%

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effort to greatly increase the capacity of roadways by the use of small vehicles connected together in flexible group configurations. Each vehicle is intended to be a one- or two-seater with half the dimensions of current cars and only a third of the weight. Two, three, four or even as many as 16 such vehicles (including trucks) might be electronically or mechanically locked together in a 1x2, or up to a 4x4, platoon configuration while traveling on a freeway.

Part three consists of active driver assistance systems. The type of assistance given could range from aged driver or handicap assistance all the way to high-speed freeway driving assistance. In addition, the system would be capable of taking over the driving function for short distances if the driver should doze off or become incapacitated.

The fourth part of SSVS is the Intelligent Intersection System. The intent is to provide drivers much better information as they enter intersections. One idea is to provide drivers with "birds-eye" views of intersection traffic. Another idea is referred to as the "guide light" system. Lights embedded in the intersection road surface would light up indicating each vehicle's intended path through the intersection.

Does all of this sound crazy to you? I'm sure many of the Japanese developments have started out that way. Who would have thought Lexus could compete with Mercedes? I admire their willingness to take risks; to try "silly" ideas, from which, with a lot of development and polishing, come innovative products.

Both the US and Japanese AVCS efforts are going to seem ridiculously visionary for some time, compared to our conventional view of the world of transportation. But remember: "Only he who can see the invisible can do the impossible." AI

Jim Haugen
is an IVHS consultant in West Bloomfield, MI.

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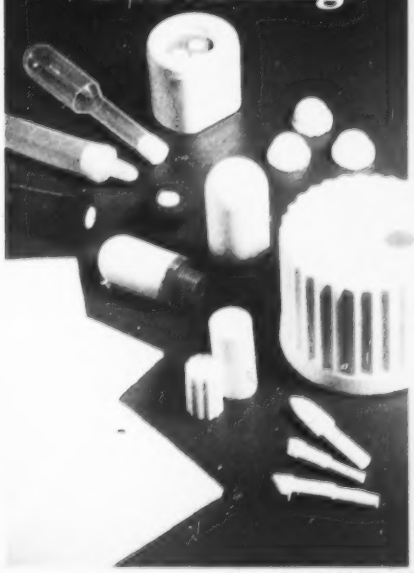

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